Energy Efficiency Potential for Data Centers

Fourth Annual California Climate Change Conference
Sacramento Convention Center
September 11th, 2007

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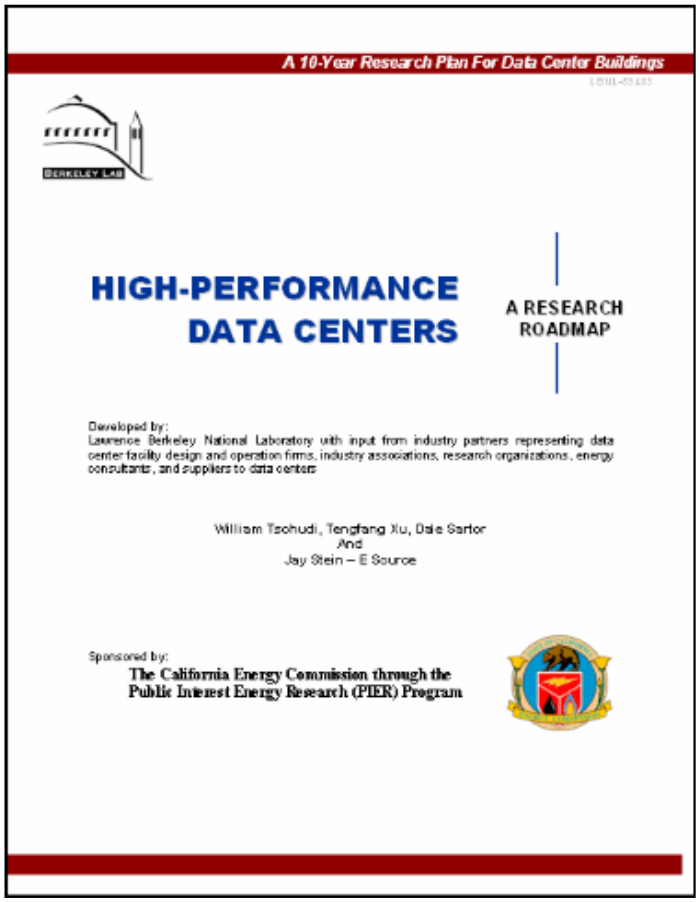
Background (PIER)

California Energy Commission Public Interest Energy Research High-tech Buildings Project Objectives

- Research, develop, and demonstrate, innovative energy efficient technologies
- 10-year initiative focusing on high-tech industries – e.g. data centers
- Help move the market to more efficient technologies
- Research and demonstration projects include technology transfer



Background (EPA)

U.S. EPA ENERGY STAR® Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431

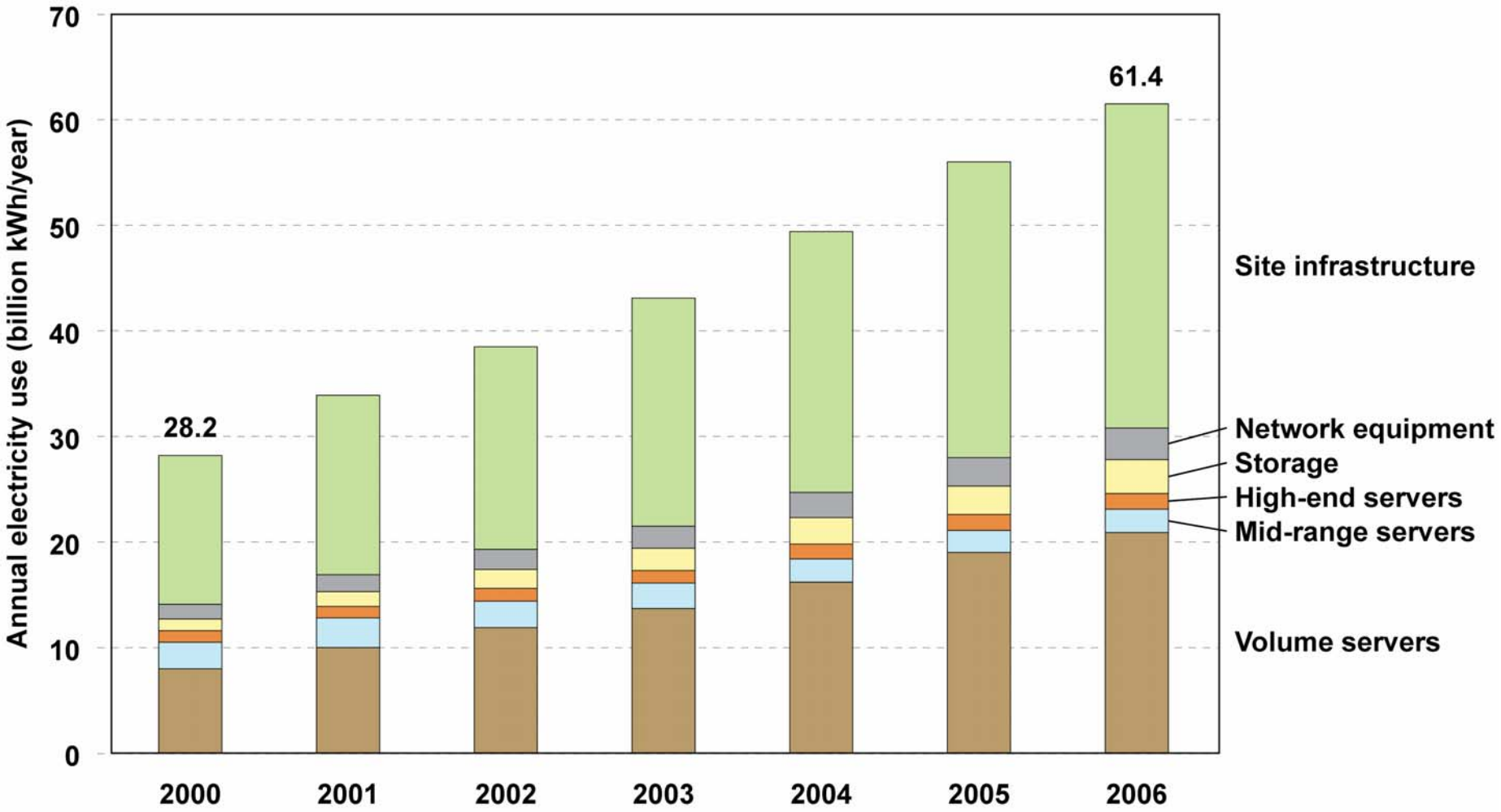
- **Purpose: assess energy impacts on and from datacenters, identify energy efficiency opportunities, and recommend strategies to drive the market for efficiency**
- **Goals:**
  - **Inform Congress & other policy makers of important market trends, forecasts, opportunities**
  - **Identify and recommend potential short and long term efficiency opportunities and match them with the right policies**
  - **Identify additional strategic research *outside the scope* of the report**
- **Extensive industry input through public workshop and review of draft report**

The significance of data centers

- **Critical national infrastructure**
- **Data centers are energy intensive facilities:**
  - **Typical facility ~ 1MW, but can be >20 MW**
  - **Data centers consumed 1.5% of total U.S. electricity in 2006 (61 billion kWh)**
    - Around $4.5 billion in electricity costs
    - Equivalent to electricity use of 5.8 million U.S. households
    - Around 39 million metric tons of CO_2 ($MMTCO_2$) emissions
- **Data centers in California:**
  - **Estimated data center load of 400-500 MW in PG&E territory alone**
    - A 400-500 MW data center load would account for around 2% of total California electricity generation (2005)
    - PG&E represents ~33% of California electricity sales

Historical data center energy use

U.S. data center electricity use by end-use component



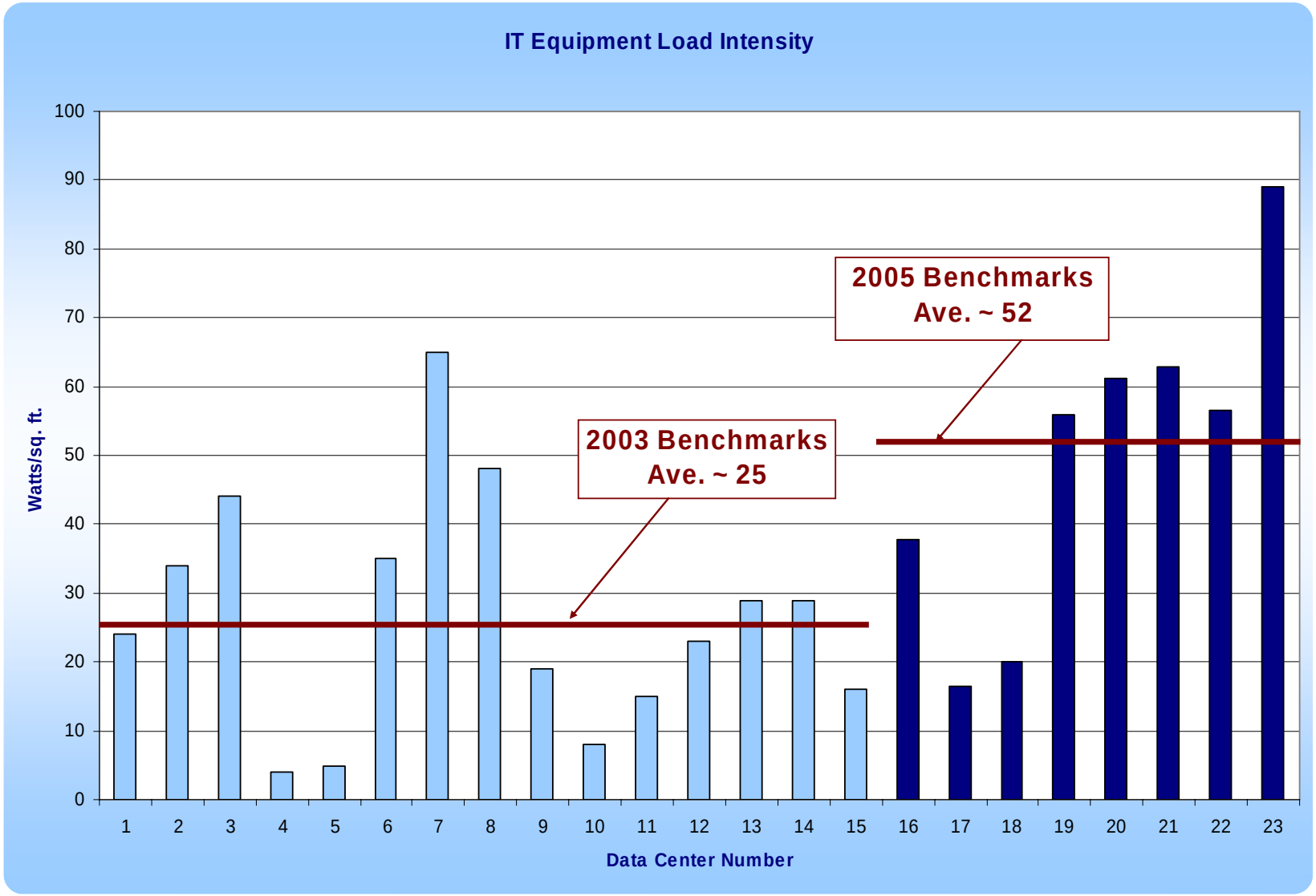
Source: U.S. EPA (2007). Report to Congress on Server and Data Center Energy Efficiency: Public Law 109-431.

Growth in data center energy use

- **U.S. data center electricity use is projected to grow to over 100 billion kWh/year over the next five years**
  - **Equivalent to 2.5% of total U.S. electricity use**
  - **Around $7.4 billion in electricity costs**
  - **Around 68 MMTCO$_2$**
- **Similar growth is likely to occur in California**
- **Significant data center building boom, partly due to power and cooling constraints in existing facilities**

Growth in power density

LBNL data center benchmarking results



Source: Tschudi and Fok (2007). Best Practices for Energy Efficient Data Centers. ASHRAE Winter Meeting. Dallas, TX, January 31.

Improvement potential

Assessment of energy efficiency opportunities for data centers:

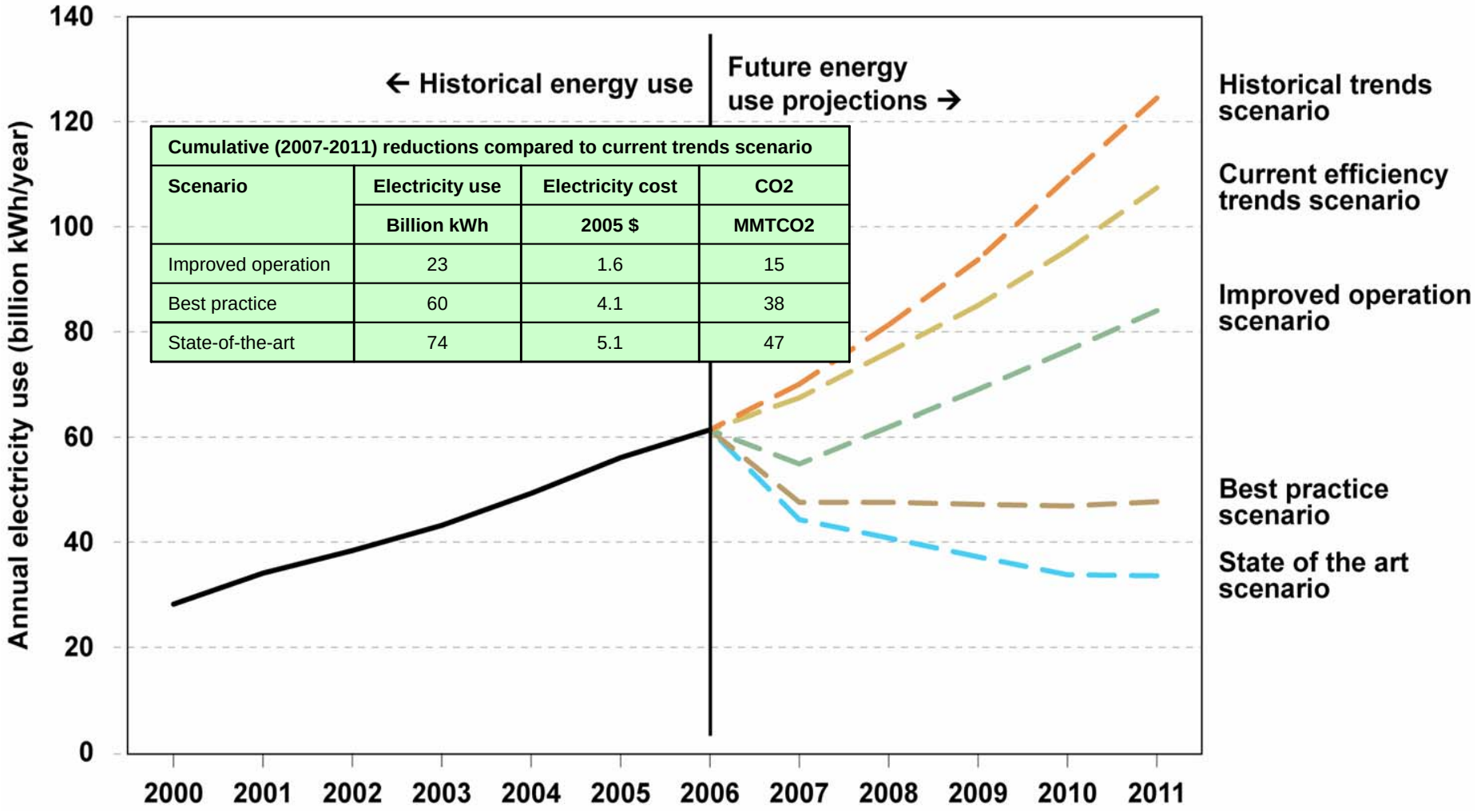
1. **Modeling of energy use and energy efficiency improvement potential for U.S. data centers**
    - Bottom-up modeling of component energy use for both IT and infrastructure systems
    - Based on measured data and observed trends
    - Scenario analysis aligned with realistic changes to technologies and practices

2. **Identification of key barriers to energy efficiency**

3. **Key recommendations for voluntary programs and incentives to improve energy efficiency**

Modeling and scenario analysis

Historical and projected electricity use of U.S. data centers



Cumulative (2007-2011) reductions compared to current trends scenario			
Scenario	**Electricity use**	**Electricity cost**	**CO2**
	Billion kWh	**2005 $**	**MMTCO2**
Improved operation	23	1.6	15
Best practice	60	4.1	38
State-of-the-art	74	5.1	47

Source: U.S. EPA (2007). Report to Congress on Server and Data Center Energy Efficiency: Public Law 109-431.

Key barriers to energy efficiency

- **Lack of efficiency definitions for equipment and data centers**
  - **Service output difficult to measure, varies among applications**
  - **Need for metrics and more data: *How do we account for computing performance?***
- **Split incentives**
  - **Disconnect between IT and facilities managers**
- **Risk aversion**
  - **Fear of change and potential downtime – energy efficiency perceived as a change with uncertain value and risk**
- **Lack of energy monitoring**
- **Information/training barriers**

Key recommendations

Public Law 109-431 recommendations:

- **Standardized performance measurements for IT equipment and data centers**
  - **Development of benchmark/metric for data centers**
    - Provides opportunity to compare and measure impacts of changes made to facility
  - **ENERGY STAR label for servers**
    - Servers are key driver of data center energy use
    - Create a standard way to measure server energy efficiency performance
- **Government leadership**
  - **Publicly report energy performance of data centers**
  - **Conduct energy efficiency assessments, all data centers in 2-3 years**
  - **Implement best practices in all data centers**

Key recommendations (continued)

Public Law 109-431 recommendations (continued):

- **Private Sector Challenge**
  - CEOs conduct energy efficiency assessments (e.g., via DOE Save Energy Now), implement measures, and report performance
- **Information on best practices**
  - Raise awareness and reduce perceived risk of energy efficiency improvements in datacenter
  - Government partner with private industry: case studies, best practices
- **Research and development**
  - Develop technologies and practices for datacenter energy efficiency (e.g., hardware, software, power conversion)

Summary

- **Growing energy use of data centers is a concern for government, companies, utilities**
  - **Concerns are particularly relevant to California**
- **However, data centers are a key energy efficiency and climate change mitigation opportunity**
- **Achieving this energy efficiency potential will require coordinated initiative involving many stakeholders to provide opportunities and address barriers**
- **Much work is underway, but great potential remains**
  - Industry is responding with improved efficiency components, systems, strategies, and partnerships
  - Federal government is actively working to develop metrics and specifications for energy efficiency in data centers and servers

Research sponsors

- **California Energy Commission Public Interest Energy Research (PIER) Program**

- **United States Environmental Protection Agency ENERGY STAR® Program**

- **Pacific Gas & Electric Company**

"Energy Efficient Digital Networks"

- A set of energy efficiency research projects all with theme of digital networks
- Proposed in 2005 — funded in 2007 by California Energy Commission Public Interest Energy Research (PIER) Program
- Covers both IT and CE products
  - Working with
    - Academia
    - Individual companies
    - Industry standards organizations
    - ENERGY STAR

http://efficientnetworks.lbl.gov/

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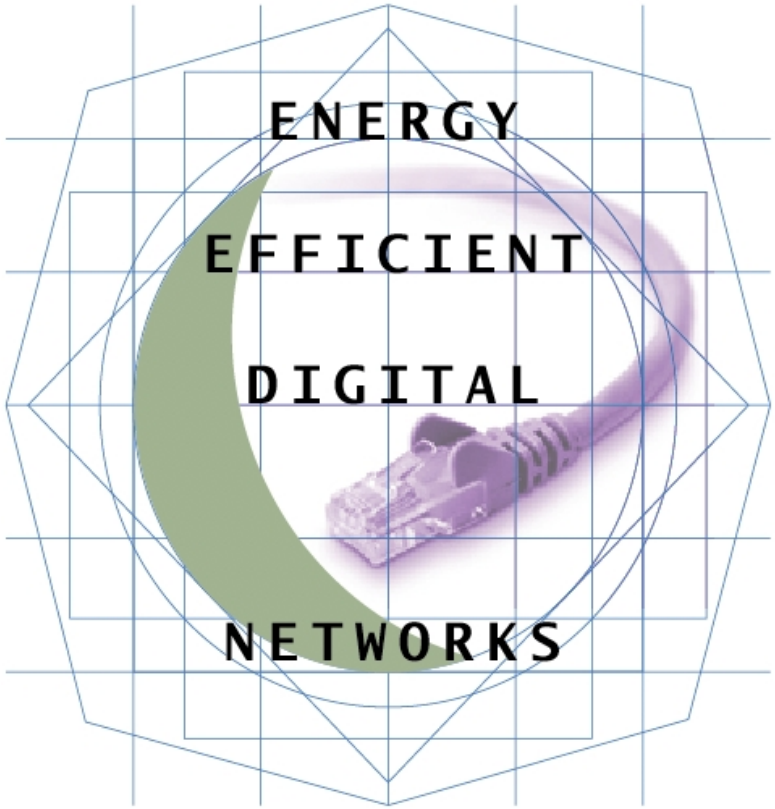

For further information

- **LBNL High-Performance Buildings for Hi-Tech Industries website:**
  http://hightech.lbl.gov/
- **U.S. EPA Enterprise Server and Data Center Energy Efficiency Initiatives website (including Public Law 109-431 report):**
  http://www.energystar.gov/datacenters
- **LBNL Energy Efficient Digital Networks project website:**
  http://efficientnetworks.lbl.gov/
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